ED 477 858 CS 512 075

AUTHOR Niederhauser, Dale S.; Shapiro, Amy

TITLE Learner Variables Associated with Reading and Learning in a Hypertext Environment.

PUB DATE 2003-04-00

NOTE 24p.; Paper presented at the Annual Meeting of the American Educational Research Association (84th, Chicago, IL, April 21-25, 2003).

PUB TYPE Information Analyses (070) -- Speeches/Meeting Papers (150)

EDRS PRICE EDRS Price MF01/PC01 Plus Postage.

DESCRIPTORS Computer Assisted Instruction; Higher Education; *Hypermedia; Literature Reviews; Reading Processes; Student Educational Objectives

ABSTRACT

While many elements like character decoding, word recognition, comprehension, and others remain the same as in learning from traditional text, when learning from hypertext, a number of features that are unique to reading hypertext produce added complexity. It is these features that drive research on hypertext in education. There is a greater degree of "learner control" when engaged in hypertext-assisted learning (HAL). In light of this increase in reader agency and responsibility when reading hypertext, researchers have begun to examine the role of various learner characteristics like individual differences, motivation, and goals on learning from hypertext. This paper reviews the literature on these learner characteristics in hypertext-assisted learning. The paper examines research on prior knowledge, field dependence/independence, navigation styles, and learning goals. It concludes that research on learner variables associated with reading and learning in a hypertext environment indicates that: it is clear that the level of the reader's prior knowledge is a critical factor in learning from hypertext; active cognitive engagement with the content and purposeful use of the linking features tends to have a positive influence on learning; and reading and learning from hypertext tends to be difficult for many readers. (Contains 46 references.) (NKA)

Learner Variables Associated with Reading and Learning in a Hypertext Environment

Dale S. Niederhauser, Iowa State University
Amy Shapiro, University of Massachusetts – Dartmouth

Draft
Please do not cite or reproduce without permission

Paper presented at the meeting of the American Educational Research Association, Chicago, IL, April 2003.

Learner Variables Associated with Reading and Learning in a Hypertext Environment

Dale S. Niederhauser
Iowa State University

Amy Shapiro
University of Massachusetts - Dartmouth

The question of how we learn from hypertext is more complicated than how we learn from traditional text. While many elements like character decoding, word recognition, comprehension, and others remain the same, a number of features that are unique to reading hypertext produce added complexity. It is these features that drive research on hypertext in education.

The most salient feature of hypertext, of course, is its *nonlinear structure*. How nonlinear structure alters learners' mental representations or ability to use their new knowledge has been an active area of research. This feature gives rise to a number of factors related to learning. Primary among these is *flexibility of information access*. Whereas traditional text allows the author to assume certain information has already been encountered allowing presentation of new information accordingly, hypertext links allow greater flexibility of access to information such that the sequence for reading is specified by each user. In other words, there is a greater degree of *learner control* when engaged in hypertext-assisted learning (HAL). In light of this increase in reader agency and responsibility when reading hypertext, researchers have begun to examine the role of various learner characteristics like individual differences, motivation, and goals on learning from hypertext.

Prior Knowledge

Central to the Schema Theory-based assumptions that underlie Cognitive Flexibility Theory (see Spiro, Coulson, Feltovitch, and Anderson, 1988; Spiro, Feltovitch, Jacobson, and Coulson, 1992) is the notion of metacognition—that the reader monitors and controls his or her own meaning making processes. Increased learner control forces the reader to interactively coordinate information accessed in the hypertext to build on and integrate with existing knowledge. Thus, as has been demonstrated repeatedly in the broader reading research, the reader's level of prior knowledge has a powerful influence on what is learned from text (see Alexander, Kulikowich, and Jetton, 1994). Thus, the complexity of one's prior knowledge would seem to be an important factor that would interact with textual and contextual factors in HAL.

Readers tend to come to a hypertext with differing levels of *prior knowledge* and this variable has received considerable attention in the context of HAL. Specifically, research has yielded fairly consistent findings concerning the relationship between prior knowledge and different levels of control (Balajthy, 1990; Dillon & Gabbard, 1998; Gall & Hannafin, 1994; Large, 1996; Tergan, 1997). That is, low prior knowledge readers tend to benefit from more structured program-controlled hypertexts while high prior knowledge readers tend to make good use of systems that allow more learner control. Gall and Hannafin (1994) state "Individuals with extensive prior knowledge are better able to invoke schema-driven selections, wherein knowledge needs are accurately identified a priori and selections made accordingly. Those with limited prior knowledge, on the other hand, are unable to establish information needs in advance, making their selections less schema-driven."

Some studies have shown advantages to using a highly organized system structure like a hierarchy. Simpson and McKnight (1990) suggest that a well-structured system can augment learning. They presented subjects with a 2500-word hypertext on houseplants. Subjects were shown indexes listing the system content that were either structured hierarchically or alphabetically. In other words, only one system organized the information according to conceptual relationships. The differences between groups' learning outcomes were marked. The hierarchical group outperformed the alphabetical group on a posttest of content and was better able to reconstruct the organization of content in a mapping posttest.

Does this mean that highly organized, hierarchical structures are always superior? Research on learning from traditional text would suggest so. A large body of literature on the relevance to hierarchical structures to learning has shown that such well-defined structures are important to information acquisition (Bower, Clark, Lesgold, and Winzenz, 1969; Eylon & Reif, 1984; Kintsch and Keenan, 1974) and expert performance and problem solving (Chase and Simon, 1973; Chi and Koeske, 1983; De Groot, 1965; Friendly, 1977; Hughes and Michton, 1977; Johnson, 1967). This work largely influenced the design of hypertext systems from the beginning.

However, system structure need not be hierarchical to benefit novices. The important characteristic for low knowledge learners is that the conceptual relationship between documents be made clear. This was demonstrated by Shapiro (1999). In that study, low prior knowledge subjects were assigned to work with either a hierarchy, an arrangement of thematic clusters, an unstructured collection of interconnected documents, or a linear (electronic) book. All system conditions presented the same documents about animal biology.

A cued-association posttest showed that subjects in all three hypertext conditions were able to recall the conceptually related topics, which were presented through system links. Subjects assigned to the electronic book condition differed significantly in this regard from those in the linked conditions. (The possibility of a repetition effect through simply seeing the link button names was ruled out with a separate control condition.) Learning across conditions was shown to be shallow, however, as all groups performed poorly on a problem-solving posttest. A closer look at the data, however, revealed that problem-solving performance was related to an interaction between the user interface and navigation pattern. Specifically, the Clustered condition presented short phrases adjacent to each link button that provided some detail about the relationship between the current document and the one represented by the link. The data revealed a significant correlation between the actual use of these buttons and performance on corresponding inferential items. Simply put, subjects were more likely to get a problem solving question correct when they actually used the link that joined the documents relevant to the question.

In this case, not even the hierarchical structure aided subjects in creating a meaningful understanding of the material. However, the use of more explicit pointers to conceptual relationships was related to an increase in problem solving ability. The important point about this study is that there is nothing "magical" about hierarchies for novices. Rather, any device that will explicate the conceptual relationships between topics can aid low knowledge learners.

While most of the research examining hypertext has been conducted with adult readers, Shin, Schallert, and Savenye (1994) examined the relationship between prior knowledge and learner control on the learning of 110 second-grade students. A simple hypertext on food groups was presented in a free access condition that allowed students to access every possible topic in the lesson in any order through a button-driven network structure. The same text was also presented in a limited-access form that had a hierarchical structure allowing the students to choose only topics that were related to the topic just presented. Both texts were also divided into an advisement condition, in which the program made suggestions to the reader on how to proceed, and a no advisement condition. Students completed paper-and-pencil pre- and posttests to assess their learning of the content. Results were consistent with findings of studies with adult readers. According to the authors, ". . . high prior knowledge students seemed able to function equally well in both conditions whereas low prior knowledge students seemed to learn more from the limited-access condition than from the free access condition." (p.43).

Field Dependence / Independence

Another important individual difference that has received attention in the literature is the effect that learning style, or *cognitive style*, has on learning from hypertext under different treatment conditions. As our explanation of the interaction between active learning strategies and system structure showed, individual differences in learning style are often important to the learning outcomes. This is so largely because they interact with other factors such as system structure.

Some researchers believe that there may be a relationship between types of navigational strategies in hypertext and whether the learner is field-dependent or field-independent. Field-independent learners tend to be more active learners and use internal organizing structures more efficiently while learning. Thus, it would seem that degrees of structure in hypertext would be related to the learning outcomes for field-dependent/independent learners.

Lin and Davidson-Shivers (1996) examined the effects of linking structure type and field-dependence and independence on recall of verbal information from a hypertext. One hundred thirty-nine university students read one of five hypertext-based instructional programs on Chinese politics. Treatments included linking structures with varying degrees of structure from linear to random. Field dependence/independence was determined by the Group Embedded Figures Test and learning was assessed through a 30-item fact-based multiple-choice test on the content provided in the lesson. According to the authors, subjects who were more field independent had higher scores on the recall measure regardless of treatment group. That is, the authors did not find a significant interaction between linking structure type and field dependence/independence.

These measures were text-based. Thus, it is unsurprising that no effect was observed, as the posttest did not assess the kind of knowledge that would be augmented by hypertext or active strategies (see Landow, 1992). However, Dillon and Gabbard (1998) have noted the frequency of such negative results and have concluded that "The cognitive style distinction of field dependence/independence remains popular, but, as in most applications to new technology designs, it has failed to demonstrate much in the way of predictive or explanatory power and perhaps should be replaced with style dimensions that show greater potential for predicting behavior and performance." (p. 344) Although their sample size was small (only four studies), Chen and Rada (1996) also reported no general effect of active versus passive learning strategies in their meta-analysis of HAL. However, a great deal of research converges on the fact that passive engagement with a hypertext will mitigate learning outcomes when working with an unstructured hypertext. It may be that learning strategy affects learning outcomes primarily when it interacts with other factors (such as system structure).

Navigation Styles

Researchers have attempted to identify patterns of reader navigation as they read hypertext. In an early study of navigation patterns, researchers watched subjects read hypertext and identified six distinct strategies: skimming, checking, reading, responding, studying and reviewing (Horney & Anderson-Inman, 1994). Castelli, Colazzo, and Molinari (1998) examined the relationships among a battery of psychological factors and a series of navigation indices. Based on their examinations the authors identified seven categories of hypertext users and related the kinds of cognitive characteristics associated with the various patterns. However, these studies simply addressed what readers did—not the relationship between reading patterns and *learning*.

One such study attempted to relate individual characteristics that influence hypertext readers' navigation patterns to learning. For example, three different profiles have been identified in college-level readers' navigation of hypertext. Some acted as knowledge seekers, systematically working through the text to extract information. Others worked as feature explorers, trying out the "bell and whistle" features to see what they did, while others were apathetic users who examined the hypertext at a superficial level and quit after accessing just a few screens (Lawless & Brown, 1997; Lawless & Kulikowich, 1996). Lawless and Kulikowich (1996) examined navigation patterns of 41 university students who read a 150-frame hypertext on learning theories to identify the categories described above. They also examined student learning and found learner interest and domain knowledge appeared to have a significant influence on readers' navigational strategies. There was also some indication that knowledge seekers tended to learn more from the text than did feature explorers.

Other research has attempted to determine underlying cognitive characteristics that are reflected in the navigation strategies employed. Balcytiene (1999) used a highly structured 19 node hypertext on Gothic art recognition. Inserted "guiding questions" were designed to focus the readers' attention. Fifteen Finnish university students read the hypertext and completed a pretest, posttest, and interview. The pretest and posttest involved recognizing whether artifacts were Gothic and providing a rationale for their opinions.

Three reading patterns were identified. Some readers engaged in systematic reading followed by nonlinear testing and reflecting, in which readers read all the information, then revisited sections as needed. A second group was labeled systematic versus explorative reading. These readers started by exploring the hypertext, then became more systematic to locate specific information to address the guiding questions. The stimulated-recall interview revealed that they were searching the screens for cues on what to do and what to read next. Finally, some students explored the hypertext based on individual interest, then systematically read the remaining content. The authors identified two underlying characteristics for these readers. "self-regulated readers" tended to systematically extract all of the information in the text. They were more independent and exploratory in their reading patterns. In contrast, "cue-dependent readers" focused on finding the answers to the guiding questions. They were highly task oriented, looking for the "right answer" rather than learning general concepts.

Although results were not statistically significant (probably due to small sample size), the pattern of findings was of interest. Self-regulated readers went from an average of 62.5% correct on the pretest to 98% correct on the posttest, while the cue dependent group average scores actually declined slightly from 91.5% to 87.5 correct. Consistent with work reported previously in this chapter, this highly structured hypertext appeared to be more beneficial to low prior knowledge readers. Although the authors overstated their claims, it appears that further research into the self-regulated/cue-dependent distinction is warranted. Hypertext navigation is not; however, always a systematic and purposeful process. An extensive area of hypertext navigation research centers on examining the effects of reader disorientation, or becoming "lost in hyperspace" on learning. According to Dede (1988, cited in Jonassen, 1988), "The richness of non-linear representation carries a risk of potential intellectual indigestion, loss of goal directedness, and cognitive entropy." Disorientation appears to stem from two factors (Dias, Gomez & Correia, 1999; McDonald and Stevenson, 1999). First is the complexity of the HAL task. Readers must allocate cognitive resources to navigate the text, read and understand the content, and actively integrate the new information with prior knowledge. Second is what Woods (1984, cited in McDonald and Stevenson, 1999) calls the "keyhole phenomenon. The scope of document content and the overall linking structure is not apparent when one is viewing an individual screen—causing the reader to have problems locating their position in the document relative to the text as a whole.

Several researchers have attempted to address the keyhole phenomenon. Much of this work examines the effects of different types of user interfaces on user disorientation (e.g., Dias, Gomes & Correia, 1999; Schroeder & Grabowski, 1995; Stanton, Taylor & Tweedie, 1992). Unfortunately, this research is concerned with identifying system structures to promote ease of navigation rather than the effects of such structures on learning. One study compared the use of an interface called "continuous zooming" with a "jump-based" system on learning and attitude (Paez, Bezerra da Silva-Fh., and Marchionini, 1996). However, no differences in learning were identified with respect to the use of the two interfaces.

Niederhauser , Reynolds, Salmen, and Skolmoski (2000) addressed the other disorientation issue—cognitive resource allocation—by providing options to allow readers to choose their method for accessing text information and to change that method as they read. The researchers developed a hypertext describing behaviorist and constructivist learning theories that could be read in a linear fashion, moving sequentially down each branch of the hierarchy for each topic, or hypertextually by linking between related concepts on the two topics. Reading the 83-screen hypertext was part of a regular class assignment for 39 university students who participated in the study. Students were tested on the content as part of the class. Examination of navigation patterns showed that some students adopted a purely linear approach, systematically moving through each frame for one theory, then moving through the second theory in the same manner. Other students read a screen on one theory, then used a link to compare that information with the other theory, and proceeded through the text using this compare and contrast strategy. Results indicated that students who read the text in a linear fashion had higher scores on a multiple choice test of factual content and an essay that required students to compare and contrast the major themes in the hypertext. Increased cognitive load was hypothesized as the reason students who used the linking features did not perform as well on the posttests.

The need to navigate through a hypertext is a defining feature that differentiates reading and learning in a hypertext environment from reading and learning with traditional printed text. Initial navigation strategies may be adopted due to interest, motivation and intrinsic or extrinsic goals of the reader. Several authors (Niederhauser, et. al., 2000; Shapiro, 1999; Tergan, 1997; Yang, 1997) have discussed issues of cognitive load when engaging in HAL. (See Paas & Van Merrienboer, 1994; Sweller, 1988; Sweller, van Merrienboer, & Paas, 1998 for more about the problem of cognitive load during instruction). When the cognitive load associated with navigating through the text interferes with the reader's ability to make sense of the content, the reader may adopt compensatory strategies to simplify the learning task. Thus, navigation strategies may influence what the reader learns from the text, and may be influenced by the conceptual difficulty associated with the content and the learning task.

Learning Goals

Goal-directed learning appears to have a powerful influence on HAL (Jonassen & Wang, 1993). According to Dee-Lucas and Larkin (1999), "readers develop an internal representation of the text's propositional content and global organization, which forms their textbase. They also construct a more inclusive representation of the text topic incorporating related prior knowledge for the subject matter, which is their situation model. The nature of the representations developed by the reader reflects the requirements of the study goal . . ." (p. 283) Thus having a purpose for reading gives the learner a focus that encourages the incorporation of new information into existing knowledge structures in specific ways.

Curry, Haderlie, Ku, Lawless, Lemon, and Woodand (1999) conducted a study to examine the effect of providing a specific learning objective to guide the reading of a hypertext (Curry et al., 1999). Fifty university students read a 60-frame hypertext on Lyme disease. Half of the students were given a specific task to guide their learning. They were given a scenario about a man with physical symptoms and a probable diagnosis, and told to use the hypertext to determine the accuracy of the information in the scenario. The other half of the subjects were told to read the text carefully, as they would be asked a series of questions at the end. Although there were no differences found on recall measures, the concept maps that students drew did show differences. Students with a specific goal constructed more relational maps, which the authors felt demonstrated a more sophisticated internal representation of the content.

Not all specific learning goals promote deep, meaningful learning, however. Azevedo and colleagues (Azevedo, Seiber, Guthrie, Cromley, Wang, and Tron, 2002) gave subjects a goal of answering specific questions about the human circulatory system while other subjects were able to generate their own goal. Some subjects in the question-answering groups increased sophistication of their mental models of circulation, but many actually showed a decrease in sophistication. None of the subjects in the learner-generated condition showed a decrease in their mental models' quality while almost all showed an increase. Moreover, those in the self-generated goal condition demonstrated more effective use of metacognitive strategies.

Subjects in Curry and colleague's study benefited from a specific goal because it capitalized on the features offered by hypertext. The specific goal of fact finding assigned by Azevedo and colleagues was not particularly compatible with HAL. Early in the history of hypertext in educational settings, Landow (1992) wrote about the importance of matching learning goals to the uniqueness of the technology. He points out that hypertext and printed text have different advantages and that hypertext assignments should be written that compliment it. Goals like fact retrieval squander the richness of hypertext because fact-finding is not aided by multiple links. A number of studies, including that reported by Azevedo and colleagues (2002) exemplify this point.

What sort of learning goals do hypertext environments enhance? Landow (1992) suggests that assignments should be written to allow learners to capitalize on the connectivity. He implores educators to be explicit with learners about the goals of the course, the role of hypertext in meeting those goals, and to provide assignments with that in mind. In describing his own approach, Landow writes,

> ...since I employ a corpus of linked documents to accustom students to discovering or constructing contexts for individual blocks of text or data, my assignments require multiple answers to the same question or multiple parts to the same answer. If one wishes to accustom students to the fact that complex phenomena involve complex causation, one must arrange assignments in such a way as to make students summon different kinds of information to explain the phenomena they encounter. Since my courses have increasingly taken advantage of Intermedia's capacity to promote collaborative learning my assignments, from the beginning of the course,

> require students to comment upon materials and links they find, to suggest new ones, and to add materials (p. 134).

Note how Landow's approach reflects the philosophy that grounds Cognitive Flexibility Theory. Indeed, Spiro, Jacobson, and colleagues have long advocated this approach (Jacobson and Spiro, 1995; Spiro and Jengh, 1990; Spiro et al., 1988).

Some work has also been reported that examined the compatibility between learning goals and characteristics of hypertext structure. In a series of studies with university students, Dee-Lucas and Larkin (1995) examined the effect of segmenting hypertext into different sized units to examine students' goal-directed searching under these conditions. Sixty-four students with limited prior knowledge of Physics participated in the study. Two hypertexts on buoyant force were created. One had 22 units organized into three levels of detail, and a second had only nine units with each unit reading as a continuous text. Students read one version of the hypertext under two conditions, once with an information-seeking task and a second time with a problem-solving task. Readers with the more segmented hypertext tended to focus on goal-related content, resulting in detailed memory for goal units, but narrower overall recall. Readers with the less-segmented hypertext tended to explore unrelated units and recalled a broader range of content. However, when the larger size of the less-segmented text blocks made information location more difficult, fewer readers completed the goal.

The authors conclude that learning goals that require accurate recall of the text, like learning scientific terminology, require the formation of an accurate and complete textbase. Narrow, well-defined goals that require the reader to locate and/or interrelate specific content may be more efficiently achieved with hypertext that is broken down into smaller units. Conversely, learning goals that require the reader to integrate related prior knowledge (problem solving, inferential reasoning, etc.) may benefit from reading a less-segmented hypertext. Hypertext that contains larger text blocks may promote text exploration and development of a more complex mental model. Thus, a less-segmented hypertext may be appropriate for learning goals that require readers to internalize a wide range of text content or a more thoroughly developed conceptual model of the content.

In sum, the literature shows with a fair degree of consistency that learning with hypertext is greatly enhanced when the learning goal is specific; although a clear goal is not always enough to augment learning outcomes. Tasks that do not capitalize on hypertext's unique connectivity, such as fact seeking, may be enhanced by the use of a highly segmented and indexed hypertext, but can promote poor learning strategies and superficial learning. However, in most cases hypertext is designed to encourage students to seek relationships between ideas, consider multiple aspects of an issue, or otherwise promote conceptual understanding. Developers, teachers, and users who attend to these goals are most likely to reap advantages from hypertext.

Conclusion

Although still in its infancy, some important findings have emerged from research on learner variables associated with reading and learning in a hypertext environment. First, it is clear that the level of the reader's prior knowledge is a critical factor in learning from hypertext. Students with low prior knowledge tend to benefit from more structured hypertext. Structure need not be hierarchical—but the structural links must reflect clear and explicit relationships in the conceptual structure of the text. When students *use* these links, the knowledge structures in the text appear to promote the development of conceptual links in the their understanding of the content.

Further, it appears that active cognitive engagement with the content and purposeful use of the linking features tends to have a positive influence on learning. Students who have a goal in mind and purpose for reading tend to read more systematically and develop a more inclusive and complex representation of the textbase. This finding seems to be facilitated when there is a good fit between the hypertext structure, segmentation, and the purpose for reading it.

Finally, reading and learning from hypertext tends to be difficult for many readers. Added to the normal reading requirements—decoding, word recognition, comprehension, integrating with prior knowledge, and so on—are navigational demands and the need to deal with small segments of text. Thus potential learning advantages may be mitigated by additional cognitive load.

A growing body of research is beginning to shed light on some of the complex relationships associated with HAL. Good programmatic research that builds on our current knowledge base will provide further insights into the use of hypertext to promote learning. In this way we can begin to realize the full potential of HAL.

References

Alexander, P.A., Kulikowich, J.M., and Jeton, T.L. (1994). The role of subject matter knowledge and interest in the processing of linear and nonlinear texts. Revie of Educational Research, 64, 201-252.

Azevedo, R., Seiber, D., Guthrie, J., Cromley, J., Wang, H-Y., and Tron, M. (2002, April). How do students regulate their learning of complex systems with hypermedia? Paper presented at the Meeting of the American Educational Research Association, New Orleans, LA.

Balajthy, E. (1990). Hypertext, hypermedia, and metacognition: Research and instructional implications for disabled readers. Journal of Reading, Writing, and Learning Disabilities International, 6(2), 183-202.

Balcytiene, A. (1999). Exploring individual processes of knowledge construction with hypertext. Instructional Science, 27, 303-328.

Bower, G.H., Clark, M.C., Lesgold, A.M., & Winzenz, D. (1969). Hierarchical retrieval schemes in recall of categorized word lists. Journal of Verbal Learning and Verbal Behavior, 8, 323-343.

Castelli, C., Colazzo, L., & Molinari, A. (1998). Cognitive variables and pattern of hypertext performances: Lessons learned for educational hypermedia and construction. Journal of Educational Multimedia and Hypermedia, 7,(2/3), 177-206.

Chase, W.G., & Simon, H.A. (1973). Perception in chess. Cognitive Psychology, 4, 55-81.

Chen, C., & Rada, R. (1996). Interacting with hypertext: A meta-analysis of experimental studies. Human-Computer Interaction, 11, 125-156.

Chi, M.T.H., & Koeske, R.D. (1983). Network representation of a child's dinosaur knowledge. Developmental Psychology, 19(1), 29-39.

Curry, J., Haderlie, S., Ku, T., Lawless, K., Lemon, M., & Wood, R. (1999). Specified learning goals and their effect on learners' representations of a hypertext reading environment. International Journal of Instructional Media, 26(1), 43-51.

De Groot, A.D. (1965). Thought and choice in chess. The Hague, Netherlands: Mouton.

Dee-Lucas, D and Larkin, J.H. (1995). Learning from electronic texts: Effects of interactive overviews for information access. Cognition and Instruction, 13,(3), 431-468.

Dee-Lucas, D., & Larkin, J. (1999). Hypertext segmentation and goal compatibility: Effects on study strategies and learning. Journal of Educational Multimedia and Hypermedia, 8(3), 279-313.

Dias, P., Gomes, M., & Correia, A. (1999). Disorientation in hypermedia environments: Mechanisms to support navigation. Journal of Educational Computing Research, 20(2), 93-117.

Dillon, A., & Gabbard, R. (1998). Hypermedia as an educational technology: A review of the quantitative research literature on learner comprehension, control, and style. Review of Educational Research, 68(3), 322-349.

Eylon, B., & Reif, F. (1984). Effects of knowledge organization on task performance. Cognition and Instruction, 1, 5-44.

Friendly, M.L. (1977). In search of the M-gram: The structure and organization of free-recall. Cognitive Psychology, 9, 188-249.

Gall, J., & Hannafin, M. (1994). A framework for the study of hypertext. Instructional Science, 22(3), 207-232.

Horney, M. A., & Anderson-Inman, L. (1994). The electro text project: Hypertext reading patterns of middle school students. Journal of Educational Multimedia and Hypermedia, 3(1), 71-91.

Hughes, J.K., & Michton, J.I. (1977). A structured approach to programming. Englewood Cliffs, NJ: Prentice-Hall.

Jacobson, M.J., & Spiro, R.J. (1995). Hypertext learning environments, cognitive flexibility, and the transfer of complex knowledge: An empirical investigation. Journal of Educational Computing Research, 12(4), 301-333.

Johnson, S.C. (1967). Hierarchical clustering schemes. Psychometrika, 32, 241-254.

Jonassen, D. H. (1988). Designing structured hypertext and structuring access to hypertext. Educational Technology, 28(11), 13-16.

Jonassen, D. H., & Wang, S. (1993). Acquiring structural knowledge from semantically structured hypertext. Journal of Computer-Based Instruction, 20(1), 1-8.

Kintsch, W., & Keenan, J.M. (1974). Recall of propositions as a function of their position in the hierarchical structure. In W. Kintsch (Ed.), The Representation of Meaning in Memory. Hillsdale, NJ: Lawrence Erlbaum Associates.

Landow, G. (1992). Hypertext: The convergence of contemporary critical theory and technology. Baltimore, MD: The Johns Hopkins University Press.

Large, A. (1996). Hypertext instructional programs and learner control: A research review. Education for Information, 14(2), 95-106.

Lawless, K., & Brown, S. (1997). Multimedia learning environments: Issues of learner control and navigation. Instructional Science, 25(2), 117-131.

Lawless, K., & Kulikowich, J. (1996). Understanding hypertext navigation through cluster analysis. Journal of Educational Computing Research, 14(4), 385-399.

Lin, C., & Davidson-Shivers, G. (1996). Effects of linking structure and cognitive style on students' performance and attitude in a computer-based hypertext environment. Journal of Educational Computing Research, 15(4), 317-329.

McDonald, S., & Stevenson, R. (1999). Spatial versus conceptual maps as learning tools in hypertext. Journal of Educational Multimedia and Hypermedia, 8(1), 43-64.

Niederhauser, D.S., Reynolds, R.E., Salmen, D.J., & Skolmoski, P. (2000). The influence of cognitive load on learning from hypertext. Journal of Educational Computing Research, 23(3), 237-255.

Paas, F., & Van Merrienboer, J. (1994). Instructional control of cognitive load in the training of complex cognitive tasks. Educational Psychology Review, 6, 351-371.

Paez, L.B., Bezerra da Silva-Fh., J., & Marchionini, G. (1996). Disorientation in electronic environments: A study of hypertext and continuous zooming interfaces. Proceedings of the ASIS Annual Meeting, 33, 58-66.

Schroeder, E.E., & Grabowski, B.L. (1995). Patterns of exploration and learning with hypermedia. Journal of Educational Computing Research, 13(4), 313-335.

Shapiro, A. (1999). The relevance of hierarchies to learning biology from hypertext. Journal of the Learning Sciences, 8(2), 215-243.

Shin, E., Schallert, D., & Savenye, W. (1994). Effects of learner control, advisement, and prior knowledge on young students' learning in a hypertext environment. Educational Technology, Research and Development, 42(1), 33-46.

Simpson, A., & McKnight, C. (1990) Navigation in hypertext: structural cues and mental maps. In R. McAleese and C. Green (eds.) Hypertext: State of the Art . Oxford: Intellect.

Spiro, R. J., & Jehng, J. C. (1990). Cognitive flexibility and hypertext: Theory and technology for the nonlinear and multidimensional traversal of complex subject matter. In D. Nix and R. Spiro (Eds.), Cognition, education, and multimedia: Exploring ideas in high technology (pp. 163-205). Hillsdale, NJ: Lawerence Erlbaum Associates.

Spiro, R, Coulson, R., Feltovitch, P., and Anderson, D. (1988). Cognitive flexibility theory: Advanced knowledge acquisition in ill-structured domains. In Tenth annual conference of the cognitive science society, pp. 375-383, Hillsdale, NJ: Erlbaum.

Spiro, R, Feltovitch, P., Jacobson, M., & Coulson, R. (1992). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. In Constructivism and the technology of instruction: A conversation, T. Duffy and D. Jonassen (Eds.), pp. 57-75., Hillsdale, NJ: Erlbaum.

Stanton, N.A., Taylor, R.G., & Tweedie, L.A. (1992). Maps as navigational aids in hypertext environments: An empirical investigation. Journal of Educational Multimedia and Hypermedia, 1(4), 431-444.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12, 257-285.

Sweller, J., van Merrienboer, J.G., & Paas, F.G. (1998). Cognitive architecture and instructional design. Educational Psychology Review, 10(3), 251-296.

Tergan, S. (1997). Multiple views, contexts, and symbol systems in learning with hypertext/hypermedia: A critical review of research. Educational Technology, 37(4), 5-18.

Yang, S. (1997). Information seeking as problem-solving using a qualitative approach to uncover the novice learners' information-seeking processes in a Perseus hypertext system. Library and Information Science Research, 19(1), 71-92.

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

ERIC
Educational Resources Information Center

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Learner Variables Associated with Reading and Learning in a Hypertext Environment

Author(s): Dale S. Niederhauser

Corporate Source:

Publication Date: April 2003

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents	The sample sticker shown below will be affixed to all Level 2A documents	The sample sticker shown below will be affixed to all Level 2B documents
PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 1	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2A	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2B
Level 1 ☑	Level 2A ☐	Level 2B ☐
Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.	Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only	Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here, please →

Signature:	Printed Name/Position/Title: Dale Niederhauser Asst Professor	
Organization/Address: Iowa State University N031 Lagomarcino Hall Ames, IA 50014	Telephone: 515-294-6841	FAX:
	E-Mail Address: dsn@iastate.edu	Date: 6/4/03

(Over)

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, *or*, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

ERIC CLEARINGHOUSE ON ASSESSMENT AND EVALUATION
UNIVERSITY OF MARYLAND
1129 SHRIVER LAB
COLLEGE PARK, MD 20742-5701
ATTN: ACQUISITIONS

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility
4483-A Forbes Boulevard
Lanham, Maryland 20706

Telephone: 301-552-4200
Toll Free: 800-799-3742
FAX: 301-552-4700
e-mail: ericfac@inet.ed.gov
WWW: http://ericfacility.org